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Publication date:
2008

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Presentation type: talk

The magnetism of nanoparticles is essentially different from that of the corresponding bulk materials, both concerning structure and dynamics. The dominant type of excitations is an in-phase coherent precession (q=0) of all spins in the effective anisotropy field, known as collective magnetic excitations (CME). Another type is the flipping af the full particle moment, also known as superparamagnetism (SPM). The latter is important for applications in magnetic data storage, since it effectively causes the nanoparticle to loose its memory.

Using inelastic neutron scattering, the authors have over the last decade studied a number of features of the dynamics of antiferromagnetic nanoparticles, and have e.g. directly observed CME and SPM. Although the theory was developed for ferromagnets, it seem to apply to antiferromagnets as well.

In this work we have studied the common mineral hematite (a-Fe2O3). For nanoparticles of d=8 nm, our observations were surprising. We expected a minor decrease of CME frequency with increasing temperature due to anharmonicities in the potential. In stead, we observed a 60% increase in frequency.

In order to resolve this apparent discrepancy, we performed classical numerical simulations of the spin dynamics in a nanoparticle. To simulate the heat bath, we used Langevin dynamics, which yields the temperature on an absolute scale.

The simulations reproduce the experimental data surprisingly well; in particular the increase in precession frequency. We find that, with increasing temperature, the angle between the two sublattice magnetisations deviate from 180 degrees. The resulting torque from the exchange interactions causes a fast rotation of both sublattices. We hence have discovered a new, exchange driven dynamic mode in antiferromagnetic nanoparticles.